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資料1 要請書 (T/R)、S/W、M/M

TERMS OF REFERENCE  
FOR  
MASTER PLAN REVIEW  
AND  
FEASIBILITY STUDY  
FOR  
WATER SUPPLY SYSTEM  
IN  
LINDI AND MTWARA REGIONS

DECEMBER 1996

MINISTRY OF WATER  
THE UNITED REPUBLIC OF TANZANIA

Terms of Reference  
for  
Master Plan Review and Feasibility Study  
for  
Supply System in Lindi and Mtwara Regions

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## 1. Introduction

The two region of Lindi and Mtwara are situated in the south -eastern corner of Tanzania Mainland. Total area of the two regions is 82,753 km<sup>2</sup>, which is about 9.3% of the whole Tanzania.

Water Master Plan for the two regions was completed in 1976 and was once updated in 1986 under finance from Finland.

From the assistance of Donors, especially that from Finland, after updating of the water master plan there were significant developments of water supply system.

However, after suspension of Aid from Finland in 1992, there are no significant support for development and maintenance of water supply system in the two regions.

Moreover, as it is 10 years since the water master plan was updated, there is a need for further updating of water Master Plan to meet the current demands and future developments of the water supply system.

The Government of Tanzania therefore requests the Technical Assistance from the Government of Japan for the water Master Plan review and Feasibility Study for future strategy of the water supply in the two Regions.

## 2. Background Information

### 2.1. Natural Conditions

The following are abstracts from the Master Plan Update (1986) which describe the natural conditions in the two regions.

-Quote-

The total area of the two regions is 82,753 km<sup>2</sup>, Mtwara Region covering 16,707 km<sup>2</sup>, and Lindi Region 66,046 km<sup>2</sup>. Less than one per cent of the total area is covered by water. The area of small lakes in the regions is insignificant. The only major water is that of the Ruvuma River, the Tanzania side of which covers some 150km<sup>2</sup> in Mtwara Region.

The topography of the south -eastern parts of Tanzania is mostly low and slightly undulating. The dominant features are two plateau areas, the Makonde and Rondo plateaus, as well as some river valleys, i.e. those of the Ruvuma, the Lukuledi, the Mbemkuru and Matandu. The Makonde Plateau which slopes gradually towards the coast has an altitude of 600 to 900 metres above sea level. It separates the coastal area from the lower basement area west and south of Masasi town. In the north, across the Lukuledi valley, lies the smaller Rondo Plateau which reaches a maximum elevation of 900 metres, the medium altitude of the plateau being around 600 metres.

Except for the plateau areas, the terrain rose gradually towards the hinterland, a major part of the areas lying at an altitude of less than 500 metres. The largest river valley in the project area is the Ruvuma Valley which descends gently towards the Indian Ocean from the Mtwara - Ruvuma regional boundary to the sea, the slope being some 250 metres within a distance of 300 km.

The area has a two season climate: a hot and humid rainy season from November/December to April/May and a cooler less humid dry season from June to October. The pattern of rainfall is single peaked with an April maximum. Although with often less rain in February than either January or March. Mean annual rainfall ranges from 800 mm to 1,200 mm. Variability is great, however, with extreme totals of 200 mm and 2,000 mm having been recorded at several locations. Air temperatures are slightly higher along the coast than inland with monthly averages ranging from 27 degrees at the Kilwa coast in March to 22 degrees in Nachingwea in July. Relative humidity is also highest in the coastal areas averaging 87 % at Lindi town during March to April.

Three geological zones can be identified: a coastal sedimentary zone, a central zone of Precambrian Basement Rocks and sedimentary zone in the western side of the project area. Landform is closely related to geology.

The outstanding feature of the vegetation is its complexity, particularly in coastal areas. A long history of disturbance by man has resulted in different stages and forms of secondary growth. In the coastal sedimentary zone, thicket development is often of bush clearing for cultivation, while isolated forest remnants reflect the original vegetation. On the central plain the vegetation is less disturbed consisting of woodland/ bush land on higher ground with grassland in the drainage lines.

-Unquote-

## 2.2. Urbanization of Lindi and Mtwara Regions

The main industry in the two regions is agriculture, producing mainly cashew nuts, coconut, sorghum, cassava, maize and rice. In 1985, the annual GDP per capita was USS 168 in Lindi Region and USS 195 in Mtwara, while it was USS 250 in the whole of Tanzania.

Urbanization has been progressing slowly but steadily.

From the updated water master plan population data and estimation on urban and rural areas are as follows:

|                | <u>1984</u> | <u>2001</u> |
|----------------|-------------|-------------|
| Rural Area     | 1,259,600   | 1,616,700   |
| Urban Area (A) | 203,100     | 494,800     |
| Total (B)      | 1,462,700   | 2,111,500   |
| A/B %          | 16.1        | 23.4        |

### 2.3. Water Supply System

Since independence, the Government of Tanzania has been giving high priority to provision of clean and safe water to rural inhabitants. As a target, water carrying distance shall be 400 m or less by the year of 2002.

To this end, the Government made great effort with assistance of several donors, to achieve this target which today can not be achieved.

Water resources in the two regions vary from river water to deep wells.

#### 1) Shallow Wells (Hand Pump)

This is the most widely used mode. The total number of shallow wells and their working conditions are as follows:

|        | <u>1984</u> | <u>1995</u> |
|--------|-------------|-------------|
| Lindi  | 880         | 1,293 (344) |
| Mtwara | 980         | 934 (231)   |
| Total  | 1,960       | 2,227 (575) |

( )....Not working : 25.8%

#### 2) Boreholes

Before the water master plan updating, there were few boreholes.

Basing on recommendation of the updated water master plan, about 400 boreholes were drilled and put into operation. But about half of them stopped functioning due to:

- drying of water resources,
- breakdown of facilities,
- and poor financial management system.

#### 3) Urban Water Supply

There were problems based on different reasons as follows:

| <u>Town</u>      | <u>Demand</u><br><u>(Supply)</u>                     | <u>Main problems</u>  |
|------------------|--|---|
| Lindi<br>(Lindi) | 5,000 m <sup>3</sup> /d<br>(2,000 m <sup>3</sup> /d) | *Lack of supply source<br>*Inadequate and old network<br>*Presence of salt in the water |

|                            |  |  |
|----------------------------|--|--|
| Nachingwea<br>(Nachingwea) | 4,000m <sup>3</sup> /d<br>(2,500m <sup>3</sup> /d)     | *Deposition of mud within bore hole caused by deterioration of casing<br>*Over draught<br>*Caving in and collapsing of some of the Boreholes |
| Mtwara<br>(Mtwara)         | 12,000 m <sup>3</sup> /d<br>(12,000 m <sup>3</sup> /d) | *Distribution network has not been expanded  |
| Masasi<br>(Masasi)         | 2,000 m <sup>3</sup> /d<br>1,100 m <sup>3</sup> /d     | *Mwena and Mwiti gravity water schemes were damaged during 1990 floods   |
| (Masasi)                   | (1.100 m <sup>3</sup> /d)                              |  |
| Newala<br>(Newala)         | 10,658 m <sup>3</sup> /d<br>5,780 m <sup>3</sup> /d)   | *Most of the shallow wells in the area are dried out<br>*Lack of water intake capacity at Makonde treatment plant                            |

### 3. Objectives of the Study

The objectives of the study is to review the existing water master plan (including updated master plan), feasibility study and other various studies related to water supply, to update and to develop a long term master plan for phased implementation of the water supply projects with the target year of 2015. Feasibility study is to be conducted for the priority projects identified in the Master Plan Review.

### 4. Study Area

The study area is basically limited within Lindi and Mtwara Regions.

### 5. Scope of Work

The study comprises two phases, viz. Phase 1 Master Plan Review, and Phase 2 Feasibility Study. Phase 1 Master plan Review will include review and analyses of available data and information, survey of existing water supply system and water resources. Based on the results obtained from these activities, water demands in the future will be estimated. For sustainability of the existing and new schemes for the most appropriate water supply system to meet the future requirements will be proposed taking into account among other aspects the Gender issues, technical, environmental, financial, social, and economic considerations. A phased implementation programme will be proposed in which priority projects for phase 2 Feasibility Study are to be identified.

Phase 2 Feasibility Study will be carried out to confirm the technical and financial, feasibility of the selected projects for the initial stage of the implementation. Each phase includes the following study items.



## 5.1 Master Plan Review

- 1) Data collection and analysis
  - Socio-economic conditions
  - Natural conditions
  - On-going water supply projects and other related projects
  - Water supply Plans and studies
  - Socio-economic development plans and studies
  - Topographical, geological and hydrogeological data
  - Meteorological, geological, hydrological data
  - Institution and organization for management and operation and maintenance of the water supply system
  - Financial conditions of the beneficiaries.
- 2) Study of the existing water supply system
  - Review of design criteria
  - Review and analysis of capacity, function and performance of the existing facilities
  - Flow rate and water pressure measurement
  - Water leakage detection
  - Operation and maintenance
  - Water tariff collection system
- 3) Study on water sources
  - Hydrological analysis, rivers and other water bodies.
  - Ground water aquifers and other hydrogeological analysis.
  - Water quality analysis and treatment facilities.
  - Allocation, transmission and use of water sources.
  - Availability of alternative water sources.
  - Location of water intakes.
  - Environmental protection
- 4) Strategies for water supply development
- 5) Determination of the service area
  - Existing service area
  - Proposed service area
  - Priority of the areas
- 6) Estimation of served population by sub-districts
- 7) Water demands projection and allocation
  - Domestic water consumption
  - Commercial, industrial and other consumption
  - Estimation of the water demands
  - Allocation of water demands by sub-districts

8) Formulation of rehabilitation and expansion plans

9) Operation and maintenance plan

10) Preliminary cost estimates

- Construction cost
- Operation and maintenance cost

11) Implementation schedule

12) water tariff and financial plan

13) Initial environmental examination (IEE)

14) Project evaluation

15) Identification of priority projects

## 5.2 Feasibility Study

1) Planning conditions

2) Preliminary design of the facilities

3) Construction and procurement schedule

4) Organization and operation and maintenance plan

- Operation system
- Water tariff collection system
- Workshop
- Training programme

5) Projects cost estimation

- Construction
- Operation and maintenance

6) Project evaluation

- Financial evaluation
- Economic evaluation
- Environmental evaluation

7) Implementation Programme

## 6. Study Period

The study will be divided into two phases, Phase 1 master plan Review and phase 2 Feasibility Study. phase 1 Master plan Review should be prepared over a period approximately 6 months, followed by phase 2 Feasibility Study of an approximately 10 months period. Further, work for each phase will be carried out both on site in Tanzania and at home in Japan as shown in Figure 3 Tentative Work Schedule.

## 7. Expertise Required

The study will require experts in the following fields.

| <u>Classification of Expert</u>   | <u>Man-months</u> |
|---|-------------------|
| 1. Team Leader (Water Supply Planning)                                      | 17                |
| 2. Senior Civil Engineer (Hydrogeologist)                                   | 15                |
| 3. Senior sanitary Engineer<br>(Water Quality Analysis and Water Treatment) | 10                |
| 4. Drilling Engineer ( Well Construction)                                   | 10                |
| 5. Civil Engineer ( Pipeline Planning)                                      | 7                 |
| 6. Mechanical Engineer  | 8                 |
| 7. Electrical Engineer  | 8                 |
| 8. Environmental Expert   | 4                 |
| 9. Organization and Administration Expert                                   | 8                 |
| 10. Economic and Financial Expert   | 8                 |
| Total:  | 95                |

## 8. Technology Transfer and Training Programme

Throughout the study period, technology transfer to the Ministry's personnel and Regional Water Engineers from the study team is considered most desirable. In order to enhance this and satisfactory completion of the study, the Ministry will assign the following personnel as a counterpart group to the study team.

### The Ministry Counterpart Group

#### Classification of Expert

1. Project Director
2. Senior Civil/Engineer (Hydrogeologist)
3. Civil Engineer (Construction)
4. mechanical/Electrical Engineer
5. Water Quality Analyst
6. Environment Expert

7. Senior Administrative officer
8. Senior Accountant
9. Drilling Engineer

A training programme for counterpart personnel will be carried out. Fellowship for about two man-months is required in the home country of the consultant and in other places where subjects involved are available (including consultant's office, universities and other institutions). A series of lectures to enhance the knowledge and practical experience regarding water supply engineering and related fields are recommended.

## 9. Methodology

The water master plan shall prepare the maps to cover the following; Topographical, Hydrological, Hydrogeological, and Meteorological aspects studies.

## 10. Reports

The following reports shall be submitted to the Ministry.

### 1) Inception Report

An Inception Report (20 copies) shall be submitted one month after the commencement of the study. This report shall clarify the work to be carried out. It shall present the main work plan for the study and outline the programme for the investigation and survey.

### 2) Progress Report 1

Progress Report 1 (20 copies) shall be submitted after 6 months from the commencement of the study, at the end of the first on-site work in Tanzania. It shall contain the description of activities performed and the nature of data obtained during the first on-site work.

### 3) Interim Report

Interim Report (20 copies) shall be submitted 11 months after the commencement of study, at the beginning of the second on-site work. This report shall contain the outcomes of the first home work in Japan, and summarize the formulation of the overall master plan update. Priority projects to be studied under phase 2 shall also be presented in the report.

### 4) Progress Report 2

Progress Report 2 (20 copies) shall be submitted 13 months after the commencement of the study, at the end of the second on-site

work in Tanzania. This report shall present the results of the activities performed during the second on-site work, and outline the preliminary feasibility study results.

5) Draft Final Report

Draft Final Report (20 copies) shall be submitted 18 months after the commencement of the study. It shall present the final formulation of the master plan update and the feasibility study for selected priority projects. Ministry will present its comments to the study team within one month after receipt of this report.

6) Final Report

Final Reports (50 copies) shall be submitted at the conclusion of the services, not later than 20 months after the commencement of the study.

11. Undertakings of the Government of Tanzania

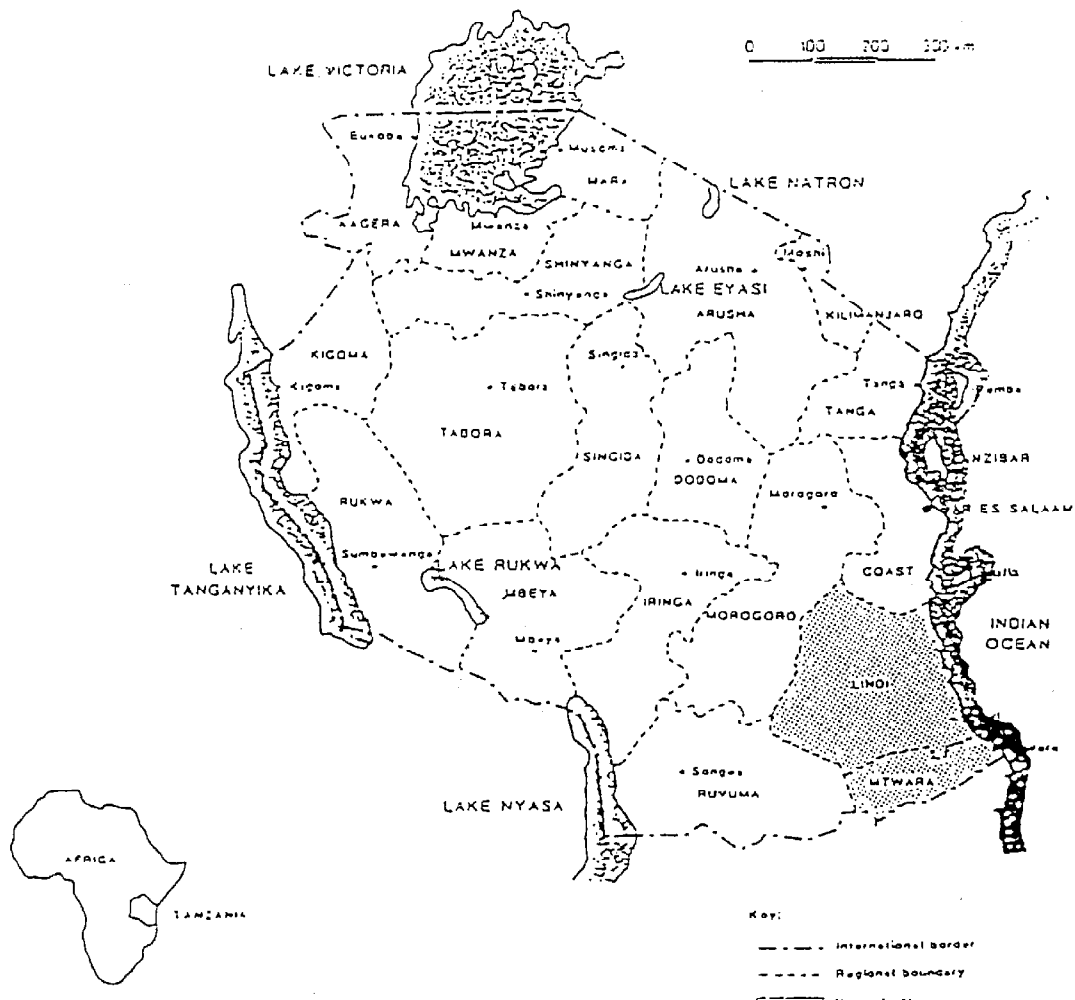
In order to facilitate the smooth and efficient conduct of the study, the Government of Tanzania will undertake the following:

1. to secure the safety of the study team
2. to permit the members of the study team to enter, leave and sojourn in Tanzania in connection with their assignments therein, and exempt them from alien registration requirements and consular fees.
3. to exempt the study team from taxes, duties and any other charges on equipment, machinery and other materials brought into and out of Tanzania for the conduct of the study.
4. to exempt the study team from income tax and charges of any kind imposed on or in connection with any emoluments or allowances paid to the members of the study team for their services in connection with the implementation of the study.
5. to provide necessary facilities to the study team for remittance as well as utilization of the funds introduced in Tanzania from Japan in connection with the implementation of the study.
6. to secure permission for entry into private properties or restricted areas for conduct of the study.

7. To secure permission for the study team to take all data, documents and necessary materials related to the study out of Tanzania to Japan.
8. to provide medical services as needed. its expenses will be charged to members of the study team.
9. to provide available maps, data and reports and other materials relevant to the study.
10. to provide counterpart personnel and support staff for the study.
11. to provide office space for study team.
12. to provide supplementary work facilities for laboratory analysis and other investigations and surveys as may be needed by the study team.

FIGURE 1

TANZANIA



MTWARA AND LINDI REGIONS





Fig. 3 TENTATIVE WORK SCHEDULE

| Description         | 1   | 2 | 3            | 4       | 5 | 6 | 7           | 8 | 9 | 10           | 11 | 12 | 13          | 14 | 15      | 16         |
|---------------------|---|---|--------------|---------|---|---|-------------|---|---|--------------|----|----|-------------|----|---------|------------|
| work in TANZANIA    | ◀-----▶   |   |              |         |   |   | ◀-----▶     |   |   |              |    |    | ◀-----▶     |    |         |            |
| Work in JAPAN       |   |   |              | ◀-----▶ |   |   |             |   |   | ◀-----▶      |    |    | ◀-----▶     |    | ◀-----▶ |            |
| Study Phase         | ◀-----[Phase 1 Master Plan Review]-----▶▶-----[Phase 2 Feasibility Study]-----▶ |   |              |         |   |   |             |   |   |              |    |    |             |    |         |            |
| Report Presentation | ▲<br>[IC/R]   |   | ▲<br>[P/R 1] |         |   |   | ▲<br>[IT/R] |   |   | ▲<br>[P/R 2] |    |    | ▲<br>[DF/R] |    |         | ▲<br>[F/R] |

Note: : IC/R : Inception Report

DF/R : Draft Final Report

P/R : Progress Report

F/R : Final Report

IT/R : Interim Report

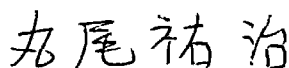
SCOPE OF WORK  
FOR  
THE STUDY ON WATER SUPPLY AND SANITATION  
IN  
LINDI AND MTWARA REGIONS  
AGREED UPON BETWEEN  
MINISTRY OF WATER  
AND  
JAPAN INTERNATIONAL COOPERATION AGENCY

Dar es Salaam, August 27, 1999



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Eng. C. N. Sayi  
Ag. Permanent Secretary,  
Ministry of Water



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Dr. Yuji MARUO  
Leader of the Preparatory Study Team  
Japan International Cooperation  
Agency



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Mr. Prosper J. Mbena  
Commissioner for External Finance  
and Debt Management,  
Ministry of Finance

## I. INTRODUCTION

In response to the request of the Government of the United Republic of Tanzania (hereinafter referred to as "the Government of Tanzania"), the Government of Japan has decided to conduct the Study on Water Supply and Sanitation in Lindi and Mtwara Regions (hereinafter referred to as "the Study") in accordance with the relevant laws and regulations in force in Japan.

Accordingly the Japan International Cooperation Agency (hereinafter referred to as "JICA"), the official agency responsible for the implementation of the technical cooperation programs of the Government of Japan, will undertake the Study in close cooperation with the authorities concerned of the Government of Tanzania.

The present document sets forth the scope of work with regard to the Study.

## II. OBJECTIVES OF THE STUDY

The objectives of the Study are:

1. to review the existing water master plan,
2. to carry out feasibility study for the priority projects identified in the Master Plan Review, and
3. to carry out technology transfer to the Tanzanian counterpart personnel in the course of the Study.

## III. STUDY AREA

The Study will cover Mtwara and southern part of Lindi Regions.

## IV. SCOPE OF THE STUDY

In order to achieve the objectives mentioned above, the Study will cover the following items.

1. Review of 1986 Master Plan

(1) Collection, review and analysis of related data and information



- a) socio-economic conditions
- b) natural conditions (topographic maps, hydrogeologic maps, meteorological data, hydrogeological data, geologic data, aerial photos)
- c) other projects relevant to the Study
- d) existing well data and existing water supply systems
- e) sanitary condition
- f) present condition and policy related to Women In Development (WID)
- g) laws, regulations and policies on water resource development and water supply and sanitation
- h) other relevant data and information
- (2) Diagnostic survey of existing water supply facilities
- (3) Assessment of water potential
  - a) investigation of existing well
  - b) review of hydrogeological condition
  - c) review of water potential
- (4) Water demand projection
- (5) Confirmation of Master Plan framework
- (6) Revision of water supply facility plan
- (7) Revision of operation and maintenance plan and institutional development plan
- (8) Public and individual hygiene awareness improvement plan
- (9) Cost estimation and evaluation
- (10) Initial Environmental Evaluation (IEE)
- (11) Selection of priority project(s)

## 2. Feasibility Study on the Priority Project

- (1) Sociological survey on present condition of the priority area
  - a) social and economic aspects
  - b) condition of water use and sanitation
  - c) culture and habits on water supply and sanitation
  - d) people's awareness on health and hygiene
  - e) people's affordability to pay for better water supply services
  - f) women's situation in society
- (2) Groundwater resources potential survey
  - a) field investigation

*[Handwritten signatures]*

- b) geophysical exploration
- c) test well drilling, well logging, pumping test
- d) water quality analysis
- e) evaluation of groundwater potential
- (3) Confirmation of planning framework
- (4) Formulation of water supply facility plan
- (5) Preliminary design of the facilities
- (6) Formulation of operation and maintenance plan and institutional development plan
- (7) Cost estimation and financial plan
- (8) Evaluation
  - a) financial and economic evaluation
  - b) institutional and technical evaluation
  - c) social evaluation
  - d) environmental impact assessment
- (9) Selection of pilot study project(s)

### 3. Pilot Study

- (1) Installation of model facilities
- (2) Pilot study on people's participation in planning and construction
- (3) Training for operation and maintenance of water supply facilities and sanitary education
- (4) Monitoring of the pilot project
  - a) observation of changes in customs and behavior of water use and hygiene practice
  - b) monitoring the operation and maintenance activities
  - c) evaluation of the pilot projects and feeding back of the lessons learned to development plan

## V. SCHEDULE OF THE STUDY

The Study will be carried out in accordance with the attached tentative schedule.



## VI. REPORTS

JICA will prepare and submit the following reports in English to the Government of Tanzania.

1. Inception Report  
Twenty (20) copies at the beginning of the first work period in Tanzania
2. Progress Report (1)  
Twenty (20) copies at the end of the first work period in Tanzania
3. Interim Report  
Twenty (20) copies at the beginning of the second work period in Tanzania
4. Progress Report (2)  
Twenty (20) copies at the end of the second work period in Tanzania
5. Draft Final Report  
Twenty (20) copies at the third work period in Japan.  
The Government of Tanzania will present its comments to JICA within one (1) month after the receipt of the Draft Final Report.
6. Final Report  
Fifty (50) copies within two (2) months after JICA's receipt of comments on the Draft Final Report

## VII. UNDERTAKINGS OF THE GOVERNMENT OF TANZANIA

1. To facilitate the smooth conduct of the Study, the Government of Tanzania shall take necessary measures:
  - (1) to secure the safety of the Japanese study team;
  - (2) to permit the members of the Japanese study team to enter, leave and sojourn in Tanzania for the duration of their assignment therein, and exempt them from foreign registration



- requirements and consular fees;
- (3) to exempt the members of the Japanese study team from taxes, duties, and other charges on equipment, machinery and other materials brought into Tanzania for the conduct of the Study;
  - (4) to exempt the members of the Japanese study team from income tax and charges of any kind imposed on or in connection with any emoluments or allowances paid to the members of the Japanese study team for their services in connection with the implementation of the Study;
  - (5) to provide necessary facilities to the Japanese study team for remittance as well as utilization of the funds introduced into Tanzania from Japan in connection with the implementation of the Study;
  - (6) to secure permission for entry into all areas concerned for the implementation of the Study within the laws and regulations in force in Tanzania;
  - (7) to secure permission for the Japanese study team to take all data and documents to Japan, as necessary for analysis during the implementation of the Study within the laws and regulations in force in Tanzania, and
  - (8) to provide medical services as needed. Its expenses will be chargeable to members of the Japanese study team.
2. The Government of Tanzania shall bear claims, if any arise against members of the Japanese study team resulting from, occurring in the course of, or otherwise connected with the discharge of their duties in the implementation of the Study, except when such claims arise from gross negligence or willful misconduct on the part of the members of the Japanese study team.
3. Ministry of Water (hereinafter referred to as "MOW") shall act as a counterpart agency to the Japanese study team and also as a coordinating body in relations with other governmental and non-governmental organizations concerned for the smooth implementation of the Study.
4. MOW shall, at its own expense, provide the Japanese study team with the following, in cooperation with other organizations

*ms* *mm* *BSu*

concerned:

- (1) available data and information related to the Study,
- (2) counterpart personnel,
- (3) suitable office space with necessary equipment in Dar es Salaam and cities to be studied, and
- (4) credentials or identification cards.

#### VIII. UNDERTAKINGS OF JICA

For the implementation of the Study, JICA shall take the following measures:

- (1) to dispatch, at its own expense and on a grant basis, study teams to Tanzania, and
- (2) to pursue technology transfer to the Tanzanian counterpart personnel in the course of the Study.









#### IX. OTHERS

JICA and MOW shall consult with each other in respect of any matter that may arise from or in connection with the Study.





## TENTATIVE SCHEDULE

|                  | 1   | 2 | 3   | 4 | 5 | 6   | 7   | 8 | 9 | 10 | 11 | 12 | 13  | 14 | 15 | 16 | 17  | 18  |          |
|------------------|---|---|---|---|---|---|---|---|---|----|----|----|---|----|----|----|---|---|----------|
| Work in Tanzania |  |   |   |   |   |   |  |   |   |    |    |    |   |    |    |    |  |   |          |
| Work in Japan    |  |   |  |   |   |  |   |   |   |    |    |    |  |    |    |    |   |  |          |
| Report           | ▲<br>IC/R   |   | ▲<br>P/R(1)   |   |   |   | ▲<br>IT/R   |   |   |    |    |    | ▲<br>P/R(2)   |    |    |    | ▲<br>DF/R   |   | ▲<br>F/R |

IC/R : Inception Report  
 IT/R : Interim Report  
 P/R : Progress Report  
 DF/R : Draft Final Report  
 F/R : Final Report

MINUTES OF MEETINGS  
ON  
SCOPE OF WORK  
FOR  
THE STUDY ON WATER SUPPLY AND SANITATION  
IN  
LINDI AND MTWARA REGIONS  
AGREED UPON BETWEEN  
MINISTRY OF WATER  
AND  
JAPAN INTERNATIONAL COOPERATION AGENCY

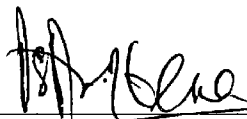
Dar es Salaam, August 27, 1999



Eng. C. N. Sayi  
Ag. Permanent Secretary  
Ministry of Water



Dr. Yuji MARUO  
Leader of the Preparatory Study Team  
Japan International Cooperation  
Agency



Mr. Prosper J. Mbena  
Commissioner for External Finance  
and Debt Management,  
Ministry of Finance

In response to the official request of the Government of the United Republic of Tanzania (hereinafter referred to as "the Government of Tanzania"), the Japan International Cooperation Agency (hereinafter referred to as "JICA") dispatched the Preparatory Study Team, headed by Dr. Yuji MARUO (hereinafter referred to as "the Team"), to Tanzania from August 17 to August 28, 1999 to discuss the Scope of Work (hereinafter referred to as "S/W") for the Study on Water Supply and Sanitation in Lindi and Mtwara Regions in the United Republic of Tanzania (hereinafter referred to as "the Study").

During its stay in Tanzania, the Team held a series of meetings with staff of Ministry of Water (hereinafter referred to as "MOW") and other authorities concerned of the Government of Tanzania and conducted a reconnaissance on the Study area. The list of those who attended these meetings is shown in the Appendix I.

The Minutes of Meetings have been prepared for the better understanding of the S/W agreed upon between MOW and the Team on August 27, 1999. The main items which were discussed and agreed by both sides are as follows,

1. Explanation of JICA's program

The Team explained JICA's Development Study program and the Tanzanian side fully understood the Program.

2. Study Title

Both sides agreed that the Study title should be revised to "the Study on Water Supply and Sanitation in Lindi and Mtwara Regions in the United Republic of Tanzania" since certain items of work related to the improvement of sanitation are included in the Study, which should be reflected to the title.

3. Study area

The Tanzanian side requested that the Study area should be entire Lindi and Mtwara Regions, as FINNIDA Master Plan covers whole area of both regions.

The Team agreed to convey this request to JICA H.Q. for consideration.



4. Target Year

Both sides agreed that the target year of Master Plan Study would be 2015, as it is requested by the Tanzanian side in the official proposal of the Study.

5. Review of the pilot study of the last JICA Development Study

The Team explained that the pilot study which was conducted in the last JICA Development Study in Singida, Tabora and Arusha regions will be reviewed in the Phase I period of the Study.

The Tanzanian side acknowledged the necessity of it.

6. Water Resources

The Tanzanian side pointed out that not only potential of groundwater but that of other possible water resources such as springs, rain water, and surface water should be investigated during the Phase II period of the Study.

The Team responded that the potential study of springs and rain water would be included in that period as alternative source of water for rural water supply other than groundwater resources potential.

7. Test Drilling and Pilot Study

Both sides agreed that some test drilling would be conducted at selected sites in the priority project area. Primary objective of these test drilling is to evaluate groundwater potential.

Only if these test wells were proved to yield sufficient amount of water, appropriate types of water supply facilities would be installed for the Pilot Study.

8. Office space and Equipment

Both sides confirmed that the Tanzanian side would provide 3 rooms and 4 rooms in regional water engineer's offices at Lindi and Mtwara respectively for the JICA Study Team.

As for Lindi, these only available rooms are necessary to be properly renovated for office use, although the authorities concerned would not be able to provide necessary fund for the renovation due to budgetary constraint.

As for office equipment the Tanzanian side also explained that they

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would not be able to provide such equipment as fax and copy machines other than desks and chairs at respective office in Lindi and Mtwara. The Team acknowledged this situation and agreed to convey it to JICA H. Q. for consideration.

9. Designation of Counterpart

The Tanzanian side assured to designate appropriate number of counterpart personnel who will cooperate with respective Japanese experts of the JICA Study Team.

10. Counterpart Training

The Tanzanian side requested that JICA conduct the counterpart training in Japan, one in JFY (Japanese Fiscal Year) 1999 and another one in JFY 2000, in order to promote technology transfer.

11. Workshop and Seminar

The Tanzanian side requested that JICA hold the workshop and/or seminar as a means of the technology transfer in the course of the Study. The Team recognized the necessity and promised to convey this request to JICA H.Q. for consideration.

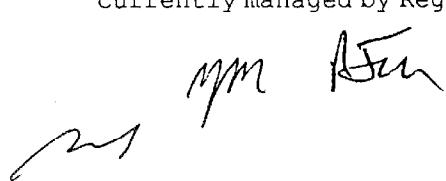
12. Steering Committee

Both sides agreed that the Tanzanian side would organize the steering committee meeting of which would be held at the time when the JICA Study Team submit IC/R, IT/R and DF/R. The member of the steering committee would be consisted of representatives of ministries and related organizations as listed below.

- (1) Ministry of Water
- (2) Ministry of Health
- (3) Ministry of Community Development, Women Affairs and Children
- (4) Ministry of Finance
- (5) Ministry of Regional Administrations and Local Governments
- (6) Regional Authorities in Lindi and Mtwara

13. Accommodation for the JICA Study Team

The Tanzanian side confirmed to provide accommodation in Lindi and Mtwara, which was used by FINNIDA experts of water projects and is currently managed by Regional Authorities, with standard government



regulations for expatriate personnel accommodation.

#### 14. Equipment

Both sides confirmed that following equipment would be basically necessary for smooth and efficient conduct of the Study.

- (1) GPS
- (2) Personal Computer for well inventory Data Base
- (3) Necessary equipment for water quality analysis
- (4) Water level measuring device

The Tanzanian side requested that the above equipment should be left for MOW to follow the Study after its completion.

The Team agreed to convey the request to JICA H. Q. for consideration. As for the necessary equipment for the geophysical exploration which will be conducted during Phase II period, it is to be considered in the Phase I.

#### 15. Vehicle for the Study

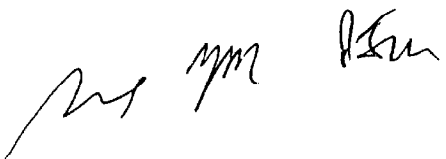
The Team requested the Tanzanian side to provide sufficient numbers of vehicles with drivers. The Tanzanian side answered that it would not be possible due to the budgetary constraint. The Team mentioned that the Team would convey this situation to JICA H. Q. for consideration.

#### 16. Reports

- (1) Timing of the submission of the reports is revised as it is shown in the Appendix II.
- (2) The Tanzanian side requested to increase the number of the reports as follows:
  - a. Inception Report, Interim Report, Draft Final Report: thirty (30) copies each, and
  - b. Final Report: sixty (60) copies.

The Team recognized it and mentioned that the Team would convey this request to JICA H. Q. for consideration.

- (3) Both sides agreed that all the reports would be open to the public in order to achieve maximum use of the Study results.



Appendix I

List of Participants

(Tanzanian side)

Ministry of Water (MOW)

|                       |                             |
|-----------------------|-----------------------------|
| Prof. Idris A. Mtulia | Permanent Secretary         |
| Mr. C. N. Sayi        | DRWS                        |
| Mr. F. W. M. Masanja  | Ag. DWR                     |
| Mr. E. C. Muziray     | ADOM(R)                     |
| Mr. R. T. Kwigizile   | ADDS(R)                     |
| Mr. R. Magesa         | Engineer(R)                 |
| Mr. I. A. Mwaka       | Executive Engineer(R)       |
| Mr. G. K. Lwakabare   | HCM(R)                      |
| Mr. C. M. W. Maheri   | Design Supervision Engineer |
| Mr. Athumawi Senkondo | Ag. Resident Engineer       |
| Mr. G. A. Saelie      | Economist                   |
| Mr. Hassani Mjengera  | Ag. HWLU                    |

Ministry of Finance

|                      |   |
|----------------------|---|
| Mr. Prosper J. Mbena | Commissioner for External Finance and Debt Management |
|----------------------|---|

Mtwara Regional Office

|                           |  |
|---------------------------|--|
| Mr. Alhaji Yahya F. Mbila | Regional Administrative Secretary                        |
| Mr. Hemedi Matuwira       | Principal Administrative Officer                         |
| Mr. M. M. Njovu           | Managing Director, Urban Water and Sewerage Authority    |
| Mr. Msaru L. Msengi       | Ag. Regional Water Engineer                              |
| Mr. Aziz Chillumba        | Design/Planning engineer                                 |
| Mr. G. W. Mwajombe        | DED, Masasi District Council                             |
| Mr. Rashibi Nambuta       | District Water Engineer,<br>Masasi District Council      |
| Mr. Simeon L. Kasumo      | Ag. District Water Engineer, Tandahimba District Council |
| Mr. Mleche W.             | RALDO  |

Lindi Regional Office

|                       |                              |
|-----------------------|------------------------------|
| Capt. U. D. Muzuzuri  | Regional Commissioner-Lindi  |
| Mr. A. Y. Mgumia      | Regional Commissioner-Kigoma |
| Mr. M. Mdidi          | RAS                          |
| Eng. Y. F. A. Monjesa | Regional Water Engineer      |
| Mr. F. Mchopa         | RAO                          |
| Mr. C. J. Mkawa       | District Water Engineer      |

(Japanese side)

JICA Tanzania Office

|                      |                                   |
|----------------------|-----------------------------------|
| Mr. Kaoru SUZUKI     | Assistant Resident Representative |
| Ms. Deborah SUNGUSIA | Assistant Programme Officer       |

Preparatory Study Team

|                       |  |
|-----------------------|--|
| Dr. Yuji MARUO        | Team Leader / Water Supply Planning                              |
| Mr. Katsumi KOBAYASHI | Member / Cooperation Planning                                    |
| Mr. Sota SEKINE       | Member / Study Planning  |
| Mr. Hiroatsu NARITA   | Member / Water Supply Planning<br>& Organization and Maintenance |
| Mr. Masakazu AOKI     | Member / Hydrogeology & Environmental<br>Consideration           |

Abbreviation

|           |   |
|-----------|---|
| DRWS -    | Director Rural Water Supply                             |
| DWR -     | Director Water Resources                                |
| ADOM(R) - | Assistant Director Operation and Maintenance (Rural)    |
| ADDS(R) - | Assistant Director Design Section (Rural)               |
| HCM(R) -  | Head of Construction and Monitoring (Rural)             |
| HWLU -    | Head of Water Laboratories Unit                         |
| DED -     | District Executive Director                             |
| RAS -     | Regional Administrative Secretary                       |
| RAO -     | Regional Administrative Officer                         |
| RALDO -   | Regional Agricultural and Livestock Development Officer |





## TENTATIVE SCHEDULE

|                  | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|------------------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|
| Work in Tanzania |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |
| Work in Japan    |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |
| Report           |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |

IC/R : Inception Report  
 P/R : Progress Report  
 IT/R : Interim Report  
 DF/R : Draft Final Report  
 F/R : Final Report

## 資料 2 対象地域の概要

### 2 - 1 地方行政制度及び地方社会

#### (1) 地方行政制度

タンザニアの地方行政制度は、中央政府の直轄になる 2 行政組織と、地方政府の所属になる 3 行政組織が、縦に組合された構成をとり、近年の地方分権化の強化に対応している。給水サービスの観点からみる場合は、末端のVillageと地方政府最上位に位置するDistrictが、最も重要な役割を担う地方行政組織とみられる。

以下に、地方行政制度の構成を図示し、簡単な解説を加える。

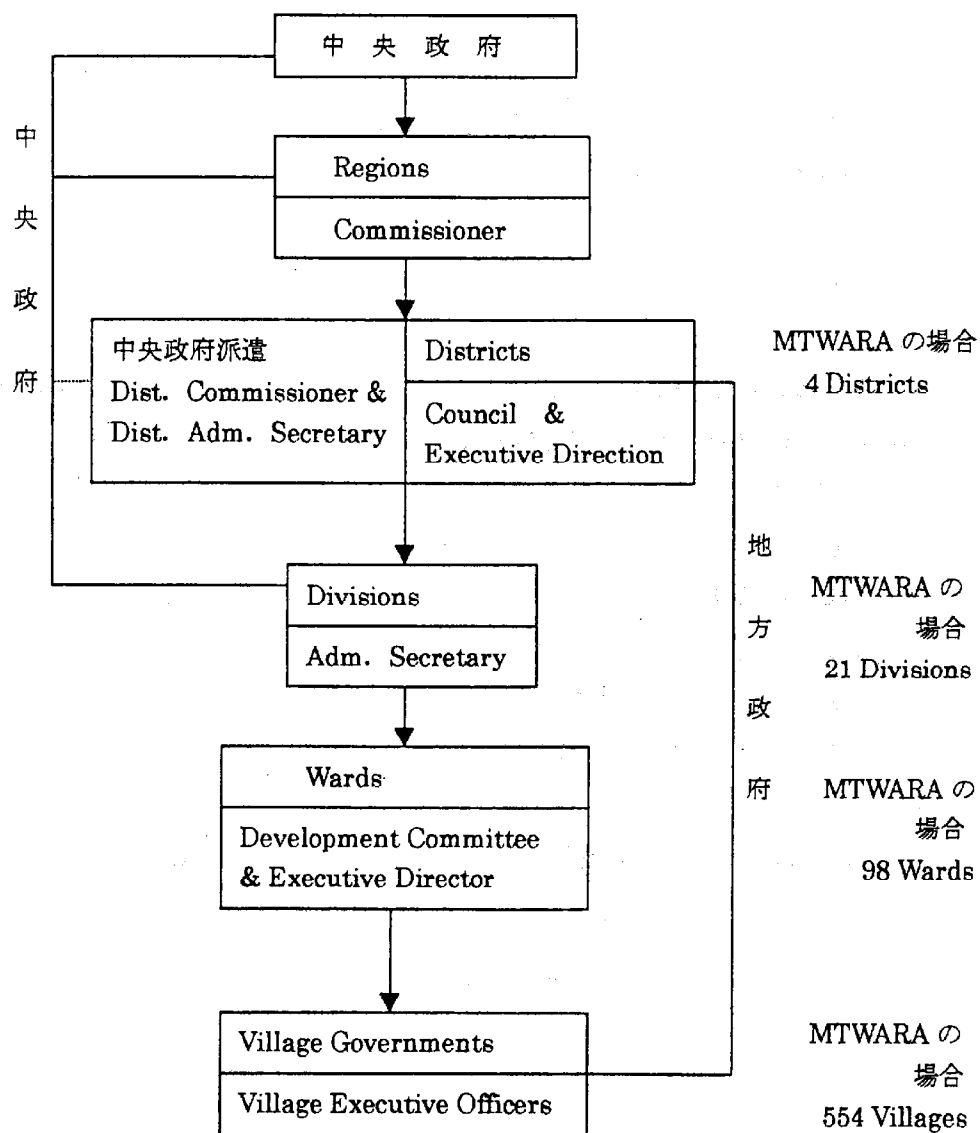


図 2 - 1 タンザニア国地方行政組織図

1) 各地方行政単位の概要は次のとおりである。

Regionは、地方行政組織の最上級の統括単位であるが、中央政府に属する。中央政府から派遣されるCommissionerや各省から派遣される職員によって運営され、民意を代表するCouncilはもたない。水省の出先機関ともいえる、Regional Water Engineer Officeをもつ。

Districtは、地方政府最上級の行政組織である。しかし、ここにも中央政府から派遣されるDistrict Commissioner、とDistrict Administrative Secretaryが駐在している。

地方政府として、民意を反映するCouncilと、それを代表してDistrictの運営にあたるExecutive Director及び自前の職員をもつ。このDistrict Water Engineer Officeは、地方の水行政上最も重要な実動部隊を抱える。

Divisionは、地方政府行政組織体のDistrict、Ward、Villageを一見分断する形で置かれた中央政府直属の行政組織体である。その行政的意義はともかく、給水サービスにかかわる地方行政に関する限りでは、かかわりが薄い存在である。

Wardは、地方政府に属するが、Councilをもたず、Development Committeeが運営している。これも、給水サービスの観点からみる限りでは、かかわりの薄い存在である。

Villageは、他アフリカ諸国での“村”の通念をはるかに超える人口（MTWARAの場合、一村平均1,850人）を擁する、地方行政の最終単位で、給水サービス上でも、単位給水区域として直接の受益対象となる。Councilをもち、次頁2）に述べるように、徴税権を与えられて、財政上もほぼ自立した自治体とみなされる。

対象Region内の、District、Division、Ward、Villageの数は、表2 - 1のとおりである。

表 2 - 1 Socio Economic Profile (1997)

(1996)

|          | MTWARA・Region | LINDI・Region |
|----------|---------------|--------------|
| District | 4             | 5            |
| Division | 21            | 28           |
| Ward     | 98            | 116          |
| Village  | 554           | 365          |
|          | (1996)        | (1999)       |
| 推計人口     | 1,005,000     | 788,000      |

2) タンザニアでは、村落共同体レベルの開発活動が重要視されているが、そのための決め手となる役割を果たすのはVillage GovernmentとDistrict Council (Town、Municipal、City Councilも含む)の2 地方政府機関であると考えられている。

Districtは担当行政区の開発活動を計画、実施、評価し、徴税を行い、これを原資として、初等教育、保健、給水、及び道路等の社会サービスを供給する。

地方、Village Governmentは、最も住民に密接する位置にあるところから、Village内の開発計画の案出、設計、及び実施を専門的技術や人材を動員して実施するのが任務で、その費用に当てるために、開発課税 (Development Levy) を徴収することが認められている。開発課税は、住民が、農林物産、畜産物、水産物を収穫し、売却して対価を得た時点で住民が支払う税である。

3) 中央政府の地方開発に関与する役割は、地方分権化の進行とともに、相対的に下がってきている。中央政府からの地方行政に対する財政的支援は補助金の形でDistrictに直接流れるが、その現在の規模や、District以下への流れは、知り得なかった。

“Ministry of Community Development, Woman Affairs and Children”の古い資料によると、会計年度1988 / 89 ~ 1992 / 93の間に中央政府より支出された地方開発向け補助金は、政府開発予算の平均2 %に過ぎず、また、経常支出予算の12 %が地方政府にまわされたが、そのほとんどが、実は地方政府内部にいる中央政府派遣職員の給与に消えてしまった、とある。地方の自助努力を強く推進しようとする国家の政策は、財政面からみても、実は、外に選択しようがない政策であることを十分にうかがわせる。

## (2) 地方社会及び人口

### 1) 概況

調査対象地域であるLINDI、MTWARAの南部2 Regionは、次のように特色づけられている (Ministry of Rural Development, Woman Affairs and Childrenからの聴取内容による)。

a) この地方は、約90 %の住民が農業に従事し、カシューナッツが、主要換金作物で、地域の所得を押し上げているが、1970年代中期の経済危機のころ、生産が大きく下落した。

元々、カシューナッツの生産部門は、古樹の改良や、新樹の植付けに日頃から十分投資しておかなければならない。1970年代には、前年代後期にこの地域で広がっていた、共同村 (ウジャマ村) の活動が、退潮期をむかえ、共同村に移住した多数の農民が、旧居住地にいっせいに回帰する動きが起った。加えて、当時の政府の、農村経

済を再編しコントロールを強化しようとする強い干渉が始まり、農民の意欲と投資の衰退を招いたといわれる。この趨勢は今も、両Regionで、人口流入を超える大きな人口流出（1.5～3倍）の社会現象となって残っている。

b) この地方は北部・中央からのアクセスに恵まれていない。中央とこの地方は、MTWARA - LINDI - KILWA - DAR ES SALAAMと海岸幹線道路で結ばれている。しかし、この道路は、全天候型でなく、雨期にはほとんど通行不能となるし、乾期ですら、車両通行は容易でない状況にある。MTWARA港とDAR ES SALAAM港を結ぶ航路の船便もあるが、決して、道路に代わり得る交通手段ではない。

c) 両地域は、人口成長率において全国平均よりはるかに低い水準にある。1978/88年の年間人口成長率で、MTWARA 1.4%、LINDI 2.0%であり、全国20 Region中最下位の成長率を示している（全国平均は、2.8%）。

これは、全国でも最高の5歳未満児死亡率 MTWARA 202人/1,000人（全国20 Region中2位）、LINDI 218人/1,000人（同1位）に代表される死亡率の高さと、先に述べた住民の流出にも若干関係すると考えられる。いずれも、社会サービスの貧困が、かなり影響しているものといえよう。

“National Account of Tanzania (1995)” から両Regionの1人当たりのGDP及び地域全体のGDP寄与率を拾い出すと表2-2のとおりとなる。

表2-2 MTWARA、LINDIの1人当たりGDP

| Region | 1人当たりのGDP    |              | GDP寄与率、1980～1994、<br>(全国20 Region中の順位) |
|--------|--------------|--------------|--|
|        | 1980         | 1994         |  |
| MTWARA | US \$<br>168 | US \$<br>108 | 3.27% (14位)                            |
| LINDI  | 120          | 65           | 2.0% (19位)                             |

1988年国勢調査時の、両Regionの人口寄与率は、MTWARAが8.4%、LINDIが2.9%であるから、全国GDPに対する寄与率はかなり低く、1人当たりのGDPが全国的水準より低いことをうかがわせる。

“Ministry of Community Development, Woman Affairs and Children”の資料によると、1983年には、農村在住の全タンザニア人の65%が貧困レベルにあり、1991年には50.5%と、やや改善されたとあるが、その基準が明らかにされていないし、両対象Regionが全国との比較で、どの程度なのか、明らかにされていない。

## 2) 地方都市

MTWARA、LINDIの2 Regionには、地方都市とみなされる次の9人口集中区域が存在する。それ等はおおむねDistrictの中心都市としての役割を果たしている。

・MTWARA Region : Mtwara Town (Regionの首都)

Mikindani Town

Newala Town

Masasi Town

・LINDI Region : Lindi Town (Regionの首都)

Kilwa ~ Masoko Town

Kilwa ~ Kivinje Town

Nachingwea Town

Liwale Town

一般に、対象Regionにおける、都市部への人口集中は、それ程急速には進んではいないし、したがって、地方都市の規模も、巨大化している村落とそれ程の人口格差はないと考えられる。これ等地方都市の人口の1988年度国勢調査時の現況と、それより10年前の1978年度国勢調査を基に、“Water Master Plan”が推計した1991年度都市人口推計値を並べてみると、表2 - 3のようになる。

表2 - 3 Region人口の比較 (センサス対推定値)

|                    | 1988年のセンサスによる都市人口     | 1978年センサスを基にW/M Planが推計した1991年の都市人口 |
|--------------------|-----------------------|-------------------------------------|
| MTWARA Regionの都市人口 | 125,124人<br>集中度 14.3% | 190,400人<br>集中度 19.0%               |
| LINDI Regionの都市人口  | 97,040人<br>集中度 15.0%  | 102,100人<br>集中度 14.8%               |

年度に3年の違いはあるが、表からWater Master Planの推計は、LINDI Regionでは適確に的を射たが、MTWARA Regionでは、大きな狂いをみせていることがわかる。この狂いは、2001年推計に更に拡大されて現れているものと考えられる。

### 3) 村落社会

対象地域の村落は、タンザニアの一般村落とはそれ程違いがあるわけでないが、他のアフリカ諸国に一般に見られる村落とは、人口規模と集村型集落形成という点で、著しく対称的である。

人口規模は、一村平均1,850人 (MTWARA Region)、1,900人 (LINDI Region) に達しており、住居は、一般に道路に沿って線状に配置され、密度の高い集村を形成している。農地を重点に、散村型の集落を形成しがちな他国の村落とは異なり、ここでは明らかに計画的な村落形成の影響が読み取られる。これは歴史的には、独立後の1967年後期に採用された社会主義的地方村落再編政策の結果誕生した、共同村 (ウジャマ村) へとさかのぼることができる。地理的に共通な条件下にある分散した小集落を、1つに集めて集村化し、これに、効率的な農業生産手段と同時に、初等教育、保健、給水等の社会サービスを無償提供しようとする共同村計画は、結局、農業生産面における失敗が明らかになるにつれ、農民に対する魅力を失い、離村して旧居住地にもどる住民が多発した。MTWARA、LINDI Regionでは、この共同村形成が最も積極的に推進されたゆえに、失敗による住民の離散もまた、最も激しく起っているといわれている。

しかしながら、大きな人口規模と、集村型村落は現在も依然として維持されており、この社会環境は、給水サービスの観点からみると、集中方式給水計画 (パイプ給水) の適用を、著しく効率的にする条件となっている。

事前調査でMTWARA Region内の村落への人口分布については、最新リストを入手しているが、LINDI Regionについては、リスト未入手である。

参考のため、MTWARA Region内の村落人口分布を表2 - 4に要約する。

表2 - 4 MTWARA Regionの村落と人口分布 (1998年)

| 人口帯 (人—人)     | 村落数            | %      | 人口 (人)  | %      | 人口寄与順位 |
|---------------|----------------|--------|---------|--------|--------|
| 500以下         | 3              | 0.60   | 1,333   | 0.15   | 9位     |
| 501 ~ 1,000   | 88             | 17.78  | 68,246  | 7.45   | 6位     |
| 1,001 ~ 1,500 | 145            | 29.30  | 179,619 | 19.62  | 2位     |
| 1,501 ~ 2,000 | 114            | 23.04  | 196,587 | 21.48  | 1位     |
| 2,001 ~ 2,500 | 57             | 11.72  | 128,174 | 14.00  | 4位     |
| 2,501 ~ 3,000 | 45             | 8.88   | 122,262 | 13.35  | 5位     |
| 3,001 ~ 3,500 | 13             | 2.62   | 42,085  | 4.60   | 7位     |
| 3,501 ~ 4,000 | 8              | 1.62   | 30,356  | 3.32   | 8位     |
| 4,001以上       | 22             | 4.44   | 146,822 | 16.03  | 3位     |
|               | 495 (人口不明、36村) | 100.00 | 915,484 | 100.00 |        |



前表から、次の特徴的な事実が指摘される。

- ・ 1,001～1,500人帯に入る村落数が最大で、全体村落の30%近くを占める。

1,501～2,000人帯の村落が第2位である。

第1位と第2位を併せた1,001～2,000人帯に入る村落で全村落の半数を超える。

- ・ 人口寄与からみると、1,501～2,000人帯の村が1位、1,001～1,500人帯の村が2位であるが、何と、4,001人以上の村が3位（全体の16%）を占める。

4) 以下にMTWARA、LINDIの主要社会統計を標示する。

表 2 - 5 対象地の社会統計

|                          | M T W A R A        | L I N D I          |
|--------------------------|--------------------|--------------------|
| 10歳以上の識字率<br>(全国順位) 1988 | 57.1% (13)         | 53.8% (16)         |
| 5歳未満児死亡率<br>1995         | 202人 / 1,000人 (17) | 218人 / 1,000人 (19) |
| 産婦死亡率<br>(全国順位) 1995     | 252人 / 1,000人 (10) | 262人 / 1,000人 (14) |
| 平均余命<br>(全国順位) 1988      | 46年 (16)           | 47年 (13)           |

(Socio Economic Profile 1997による)

( ) 内の数字は全国20州における順位

## 2 - 2 自然条件

### (1) 地形

今回の調査対象地域はタンザニア (TANZANIA) の南東部に当たり、南緯 8～11度の間、東経 37～40度に位置する。東にインド洋 (INDIAN OCEAN)、南にルバマ川 (RUVUMA River.) を隔ててモザンビーク (MOZAMBIQUE)、西にルメスレ川 (LUMESULE River) を隔ててルバマ州 (RUVUMA REGION)、西から北西にマバランガンド川 (MBARANGANDU River) とラフィジ川 (RUFIFI River) を境としてモロゴロ州 (MOROGORO REGION)、北にルフジ川 (TUFIFI River) を境としてコースト州 (COAST REGION) に挟まれた区域である。

リンディ (LINDI) 州とムトワラ (MTWARA) 州を合わせた今回の調査範囲は 8 万 3,753km<sup>2</sup>で、リンディ (LINDI) 州は 6 万 6,046km<sup>2</sup>、ムトワラ (MTWARA) 州は 1 万 6,707km<sup>2</sup>であり、図 2 - 1 にそれらの位置を示す。



図 2 - 1 リンディ (LINDI) 州とムトワラ (MTWARA) 州の位置

リンディ (LINDI) 州とムトワラ (MTWARA) 州の地形形状は東方から西方に向かうに従い標高は高くなっているが、東西の断面型をみると、大きく 3 種類の丘陵からなる。第 1 丘陵は東海岸から約 50~70km、内陸に入った所に分布する丘陵地で約 600~1,000m までの標高で、おおよそ 800m の標高で平地をなしている。第 2 丘陵は第 1 丘陵地の東西に分布する丘陵地で、約 300~600m までの標高で、おおよそ 400m の標高で平地をなしている。更に第 3 丘陵は海岸線に面した丘陵地で 10~300m までの標高で、おおよそ 100m の標高で平地をなしている。図 2 - 2 は東側のムトワラから西側のマサシ (MASASI) 間の断面型を示したものであるが、東から海岸段丘として形成された第 3 丘陵から始まり、第 2、第 1 丘陵と続き、それぞれの軟弱地盤の部分を縦横に谷が形成されている。

第 1 丘陵地に当たる主要高原はマコンデ高原 (MAKONDE PLATEAU) とロンド高原 (RONDO PLATEAU) である。マコンデ高原 (MAKONDE PLATEAU) はマサシ (MASASI) の東側に分布し、600~900m の標高をなしている。高原の中央にマンビー川 (MAMBI River) が東西方向に流れている。また、ロンド高原 (RONDO PLATEAU) はルクレンディ川 (LUKULEDI River) とマブエムブ川 (MBWEMBUR River) に挟まれた区域で平均標高 600m 程度の高原である。これらは水文地質の項でも述べるが、それぞれの高原斜面は重要な

水源となっている。

第2の丘陵は第1の高原と第3丘陵に挟まれたマブエムブ川 (MBWEMBUR River) より南側の地域と、第1丘陵地の西側に当たる基盤岩の地域、更に第1丘陵地が存在しないで、第2丘陵が広く分布するマブエムブ川 (MBWEMBUR River) より北側に大きく分かれる。それぞれの第2丘陵の台地上は一部の亀裂風化部分を省き、ほとんど水源とはなっていないが、それぞれの丘陵を切っている谷地形の部分に湧き水 (SPRING) や伏流水としての地下水源が分布している。

第3の丘陵地は主に海岸段丘と河岸段丘によって形成された地形で、おおむね地下水源としては豊富である。

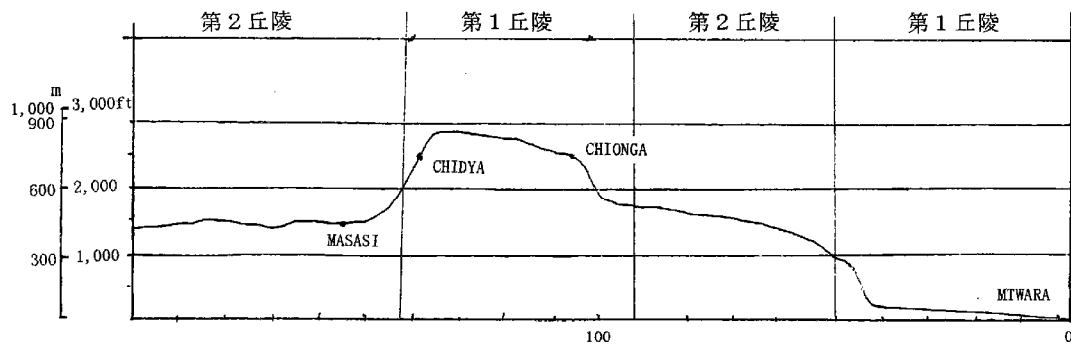


図2-2 東側のムトワラから西側のマサシ (MASASI) 間の断面型

## (2) 地質

表層の地質は大きく調査地域の中央にあたる部分で南北に切れて、西側が基盤岩、東側は白亜紀から第三紀、更に沖積層に至る堆積岩である (図2-3参照)。すなわち、南からみると、東の海岸域から150km離れたネワラ (NEWALA)、東の海岸域から125km離れたウンダダ (NDANDA)、75km離れたマングワ (MANDAWA)、更に北に進んで62.5km離れたナンジリンジ (NANJIRINJI) を境にして西が基盤岩、東が堆積岩である。

堆積岩は基盤岩の上を白亜紀と第三紀が層を成して分布し、図2-4に示すような断面形状をなす。

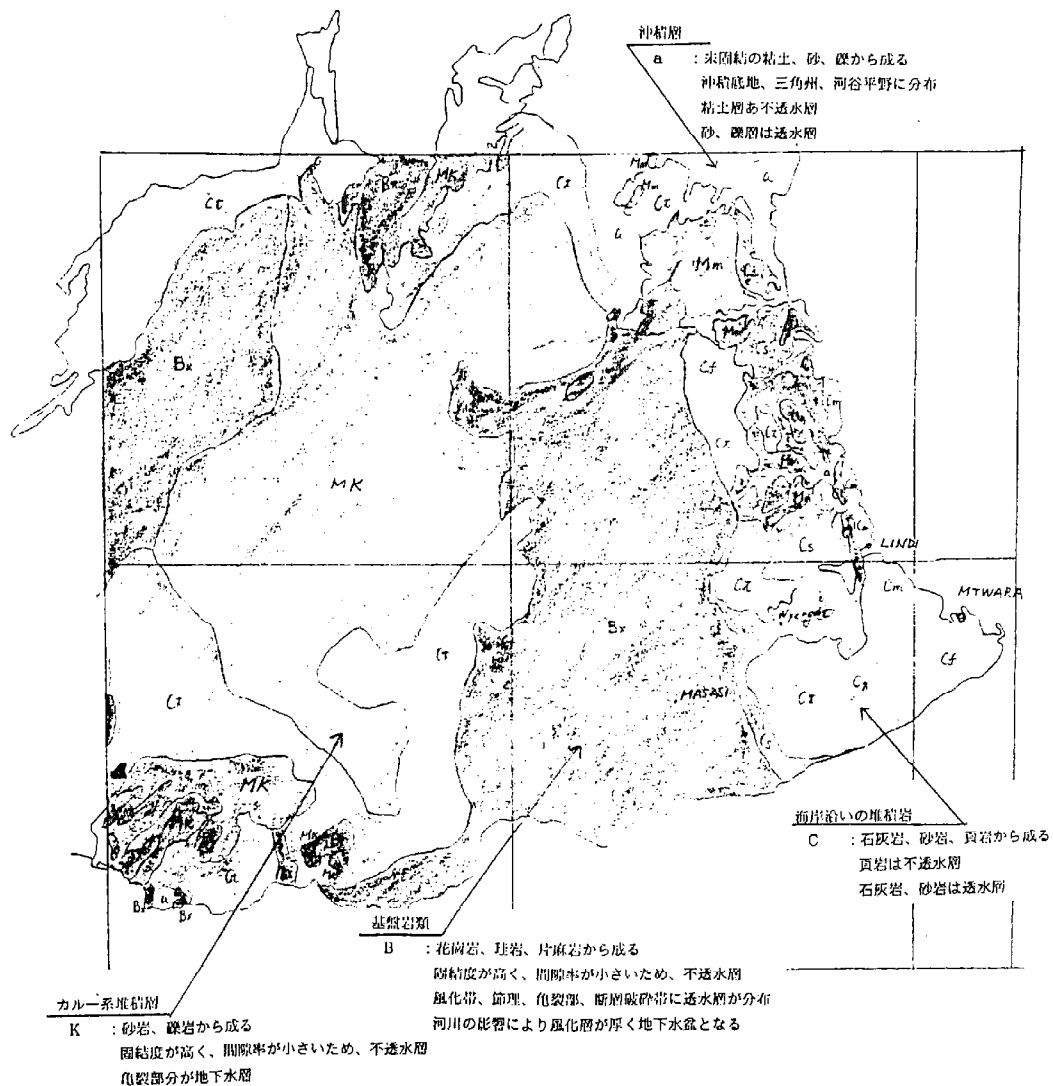


図 2 - 3 リンディ (LINDI) 州とムトワラ (MTWARA) 州の地質図

(出典 : Geology 1/2,000,000 Government of the United Republic of Tanzania)

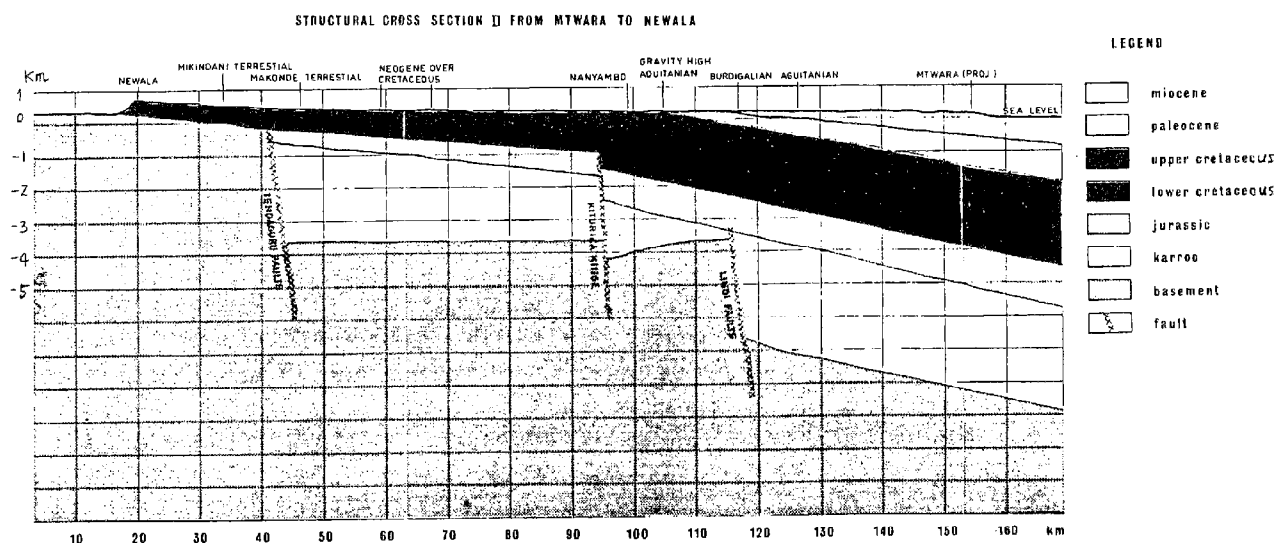


図 2 - 4 白亜紀と第三紀層からなる堆積岩が基盤岩の上に分布  
(出典: Mtwaru-Lindi Water Resources inventory Paisel Cross Section 1977)

表 2 - 6 リンディ (LINDI) 州とムトワラ (MTWARA) 州の地質図

| 地 史    |                   | 岩 石      |    |             |
|--------|-------------------|----------|----|-------------|
| 第 4 紀  | Quaternary Period | 沖積層      | a  | 粘土、砂、礫      |
| 第 3 紀  | Tertiary Period   | 海岸沿いの堆積岩 | Ct | 砂、礫         |
|        |                   |          | Cf | 砂、礫、シルト、石灰岩 |
|        |                   |          | Cm | 泥岩、砂岩、石灰岩   |
|        |                   |          | Cl | 石灰岩         |
|        |                   |          | Cs | 砂岩、礫岩       |
| 中世代    | Mesozoic          | カルー系     | Mm | 泥岩          |
| 古生代    | Palaeozoic        | 堆積層      | MK | 礫岩、砂岩       |
| 先カンブリア | Preocambrian      | 基盤岩類     | Bx | 花崗岩、珪岩、片麻岩  |

基盤岩類

B : 花崗岩、珪岩、片麻岩から成る

固結度が高く、間隙率が小さいため、不透水層  
風化帯、節理、亀裂部、断層破碎帯に透水層が分布  
河川の影響により風化層が厚く地下水盆と成る

カルー系堆積層

K : 砂岩、礫岩から成る

固結度が高く、間隙率が小さいため、不透水層  
亀裂部分が地下水層

白亜紀から第三紀の堆積岩

C : 石灰岩、砂岩、頁岩から成る

頁岩は不透水層

石灰岩、砂岩は透水層

沖積層

a : 未固結の粘土、砂、礫から成る

沖積底地、三角州、河谷平野に分布

粘土層は不透水層

砂、礫層は透水層

### (3) 気象・水文

気象・水文に関してはデータに基づく考察に寄るところがほとんどである。しかし、タンザニア政府においては観測データは1931～1976年（最大1980年）の間である英国任統治領時代からフィンランド政府による「MTWALA-LINDI WATER MASTER PLAN」のために観測されたデータのみで、それ以降のデータは存在しない。

以下、フィンランド政府による「MTWALA-LINDI WATER MASTER PLAN」ANNEX A (HYDROLOGY 1977) によると次のような報告が記されている。

#### <降雨>

この地域における降雨量は800～1,200mm/年と地域によって大きな開きがある。しかし、平均すると900mm程度である。これを1年間の累計降雨をコンタ表示したのが図2-5である。これによると内陸側で降雨が多いが海岸からやや内陸に入った個所についても1,000mmを超える分布を示している。また、月別に整理すると降雨期の11月から3月にかけては内陸側に降雨量が多く、逆に乾季の6月から10月までは海岸線の降雨の方が内陸に比べて多いことが分かる。

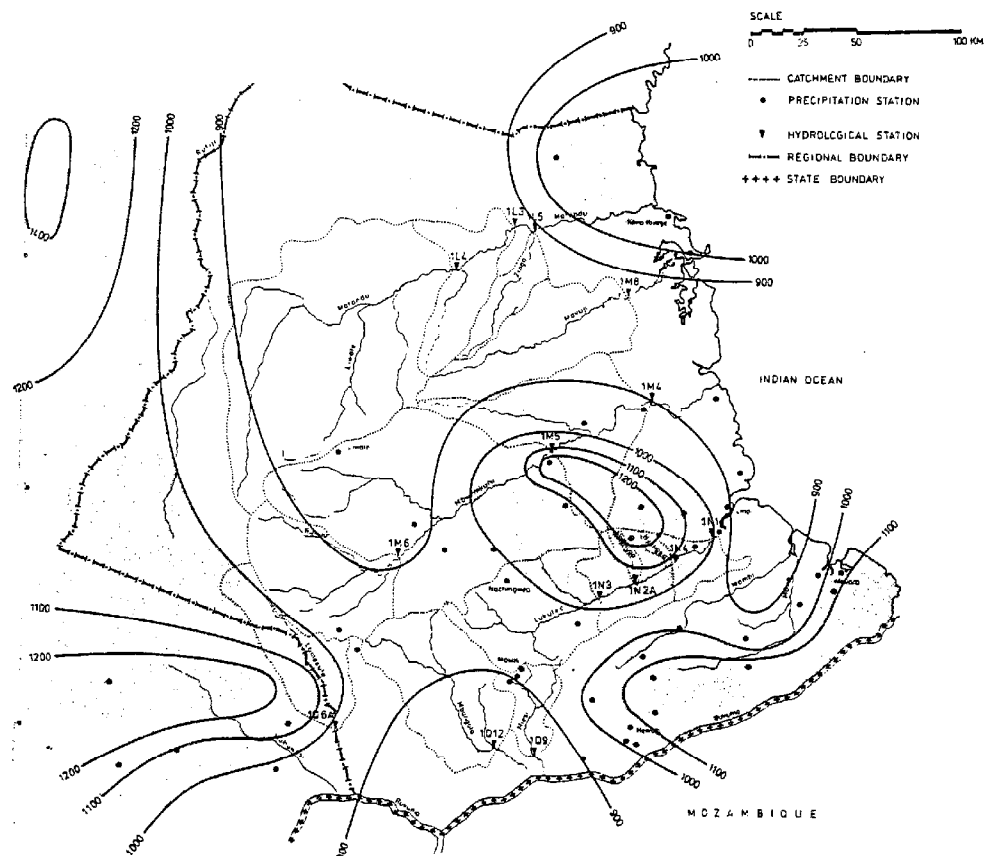


図2-5 1年間の累計降雨コンタ図

(出典: Mtwaru-Lindi Water Master Plan Hydrology 1977)

### <気温>

気温は年中を通じて大きな差がない。図2-6が示すように、例えばキルワ・キヴィンジ (KILWA KIVINJE) の最も高い2月で28度に対し最も低い6、7月で25.5度程度で、その差は2.5度と低い。温度差は内陸に行くに従い大きくなり、ナチングワア (NACHINGWEA) では6度差となっている。また、海岸線の方が温度は高く、北に行くほど温度は高くなっている。

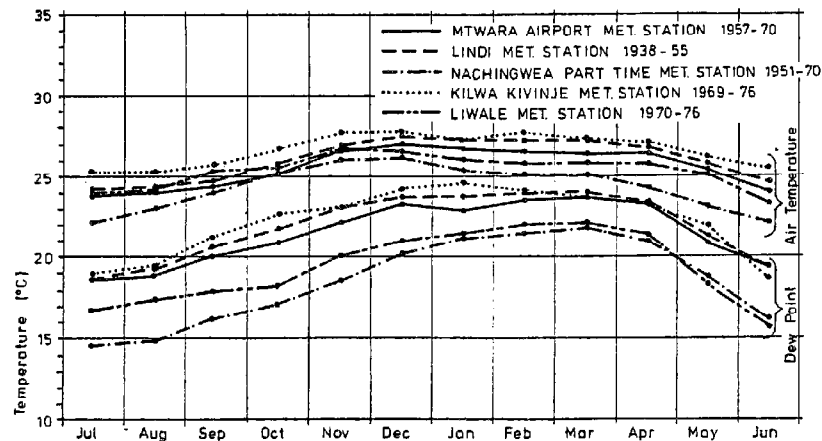


図2-6 1年間の気温変化

(出典: Mtwara-Lindi Water Master Plan Hydrology 1977)

### <水文>

#### — 流出率 —

年間の流量観測が各河川で実施されている。同じに観測された雨量観測とから流出率が求められている。表2-7はその結果を示したものであるが、1%から45%と大きく差があり、大きな傾向が認められない。そこで、これを流域面積の大きさに応じて区分すると、流域面積が大きくなると比流出量 ( $\text{mm}/\text{sec} \cdot \text{km}^2$ ) は小さくなる。このことを図にしたのが図2-7である。また、観測点各値を図面上に示し、等値線で示したのが図2-8で、流域面積の小さい段階で70mm、海岸線近くの流域面積が大きくなると20mm程度となることが分かる。これを流出率に直すと、2~8%となり、表面流出の非常に少ない事を示し、逆に、安定した水源を期待するには、地下水に寄るところが大きいことが示されている。

表 2 - 7 降雨と流量から求めた流出率

| Station<br>River/site/No.       | Catchment<br>area<br>km <sup>2</sup> | Hydrological<br>year | Discharge<br>10 <sup>6</sup> m <sup>3</sup> | Annual runoff |                       | Precipi-<br>tation<br>mm | Runoff<br>Coefficient<br>% |
|---------------------------------|--------------------------------------|----------------------|---|---------------|-----------------------|--------------------------|----------------------------|
|                                 |                                      |                      |   | mm            | l/sec km <sup>2</sup> |                          |                            |
| MATANDU AT<br>MTANGA 1.L.3      | 11260                                | 1970-71              | 278.2                                       | 24.7          | 0.78                  | 850                      | 2.9                        |
|                                 |                                      | 1971-72              | 1027.1                                      | 91.2          | 2.89                  | 884                      | 10.3                       |
|                                 |                                      | 1972-73              | 832.8                                       | 74.0          | 2.34                  | 850                      | 8.7                        |
|                                 |                                      | 1973-74              | 113.3                                       | 10.1          | 0.32                  | 850                      | 1.2                        |
| ZINGA AT<br>MIGURUWE 1.L.5      | 830                                  | 1974-75              | 14.5  | 17.5          | 0.55                  | 1030                     | 1.7                        |
|                                 |                                      | 1975-76              | 38.4  | 46.3          | 1.47                  | 870                      | 5.3                        |
| MBWEMKURU AT<br>MNYANGALA 1.M.4 | 15220                                | 1968-69              | 164.3                                       | 10.8          | 0.34                  | 771                      | 1.4                        |
|                                 |                                      | 1970-71              | 173.3                                       | 11.4          | 0.36                  | 918                      | 1.2                        |
|                                 |                                      | 1971-72              | 133.7                                       | 8.7           | 0.28                  | 1025                     | 0.9                        |
|                                 |                                      | 1972-73              | 1302.8                                      | 85.6          | 2.71                  | 915                      | 9.4                        |
| MBWEMKURU AT<br>MITONONO 1.M.5  | 11700                                | 1975-76              | 627.6                                       | 41.2          | 1.30                  | 948                      | 4.3                        |
|                                 |                                      | 1969-70              | 588.2                                       | 50.3          | 1.59                  | 956                      | 5.3                        |
|                                 |                                      | 1970-71              | 292.2                                       | 25.0          | 0.79                  | 909                      | 2.8                        |
|                                 |                                      | 1971-72              | 232.6                                       | 19.9          | 0.65                  | 1036                     | 1.9                        |
| MBWEMKURU AT<br>SINGIRA 1.M.6   | 3010                                 | 1972-73              | 941.6                                       | 80.5          | 2.55                  | 901                      | 8.9                        |
|                                 |                                      | 1973-74              | 356.5                                       | 30.5          | 0.96                  | 817                      | 3.7                        |
|                                 |                                      | 1974-75              | 168.9                                       | 14.4          | 0.46                  | 1036                     | 1.4                        |
|                                 |                                      | 1975-76              | 327.3                                       | 28.0          | 0.89                  | 905                      | 3.1                        |
| NYANGAO AT<br>NYANGAO 1.N.2.A   | 200                                  | 1968-69              | 59.0  | 19.5          | 0.62                  | 700                      | 2.8                        |
|                                 |                                      | 1969-70              | 412.0                                       | 137.0         | 4.33                  | 850                      | 16.1                       |
|                                 |                                      | 1970-71              | 149.5                                       | 49.7          | 1.57                  | 955                      | 5.2                        |
|                                 |                                      | 1971-72              | 174.2                                       | 57.9          | 1.83                  | 997                      | 5.8                        |
| NYANGAO AT<br>NYANGAO 1.N.2.A   | 200                                  | 1972-73              | 1191.9                                      | 396.0         | 12.50                 | 880                      | 45.0                       |
|                                 |                                      | 1973-74              | 330.6                                       | 109.8         | 3.50                  | 780                      | 14.1                       |
|                                 |                                      | 1974-75              | 106.7                                       | 39.4          | 1.30                  | 1043                     | 3.8                        |
|                                 |                                      | 1975-76              | 11.6  | 58.0          | 1.84                  | 1120                     | 5.2                        |
| LUKULEDI AT<br>NANGANGA 1.N.3   | 2710                                 | 1970-71              | 12.1  | 60.6          | 1.92                  | 880                      | 6.9                        |
|                                 |                                      | 1971-72              | 12.2  | 61.0          | 1.93                  | 1000                     | 6.1                        |
|                                 |                                      | 1972-73              | 13.0  | 64.9          | 2.05                  | 1050                     | 6.2                        |
|                                 |                                      | 1973-74              | 10.3  | 51.5          | 1.63                  | 1050                     | 4.9                        |
| LUKULEDI AT<br>MTUA 1.N.4       | 4170                                 | 1974-75              | 11.1  | 55.7          | 1.76                  | 1020                     | 5.5                        |
|                                 |                                      | 1975-76              | 15.4  | 77.0          | 2.44                  | 1500                     | 5.1                        |
|                                 |                                      | 1968-69              | 46.4  | 17.1          | 0.54                  | 895                      | 1.9                        |
|                                 |                                      | 1971-72              | 58.2  | 21.5          | 0.68                  | 1071                     | 2.0                        |
| LUKULEDI AT<br>MTUA 1.N.4       | 4170                                 | 1972-73              | 30.2  | 11.1          | 0.35                  | 899                      | 1.2                        |
|                                 |                                      | 1975-76              | 45.0  | 16.6          | 0.53                  | 1116                     | 1.5                        |
|                                 |                                      | 1973-74              | 60.9  | 14.6          | 0.46                  | 977                      | 1.5                        |
|                                 |                                      | 1974-75              | 72.6  | 17.4          | 0.55                  | 945                      | 1.8                        |
| LUMESULE AT<br>RUANDA 1.Q.6.A   | 1430                                 | 1975-76              | 118.5                                       | 28.4          | 0.90                  | 1205                     | 2.4                        |
|                                 |                                      | 1968-69              | 5.9   | 4.1           | 0.13                  | 700                      | 0.6                        |
|                                 |                                      | 1970-71              | 224.7                                       | 157.1         | 4.97                  | 1000                     | 15.7                       |
|                                 |                                      | 1971-72              | 80.3  | 56.2          | 1.78                  | 927                      | 6.1                        |
| LUMESULE AT<br>RUANDA 1.Q.6.A   | 1430                                 | 1972-73              | 422.1                                       | 295.2         | 9.34                  | 945                      | 31.2                       |
|                                 |                                      | 1973-74              | 133.3                                       | 93.2          | 2.95                  | 850                      | 11.0                       |
|                                 |                                      | 1974-75              | 56.0  | 39.2          | 1.24                  | 965                      | 4.1                        |
|                                 |                                      | 1975-76              | 64.8  | 45.3          | 1.43                  | 800                      | 5.7                        |

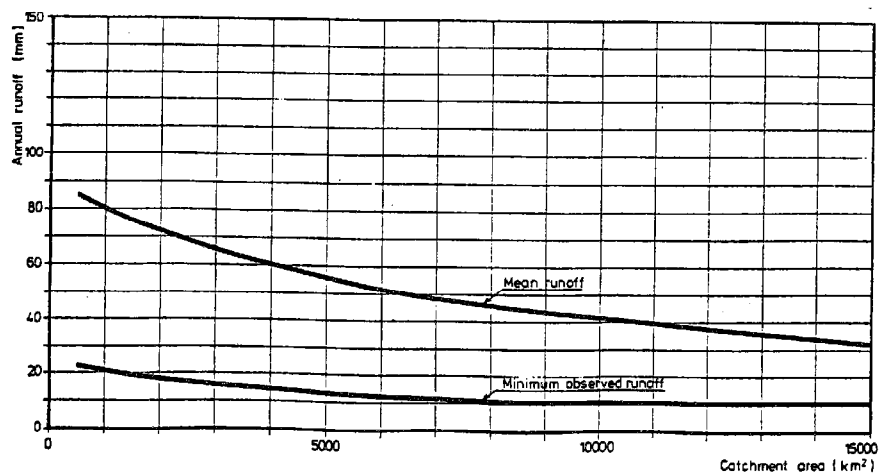


図 2 - 7 比流出量と観測点の流域面積の関係

(出典 : Mtwara-Lindi Water Master Plan Hydrology 1977)



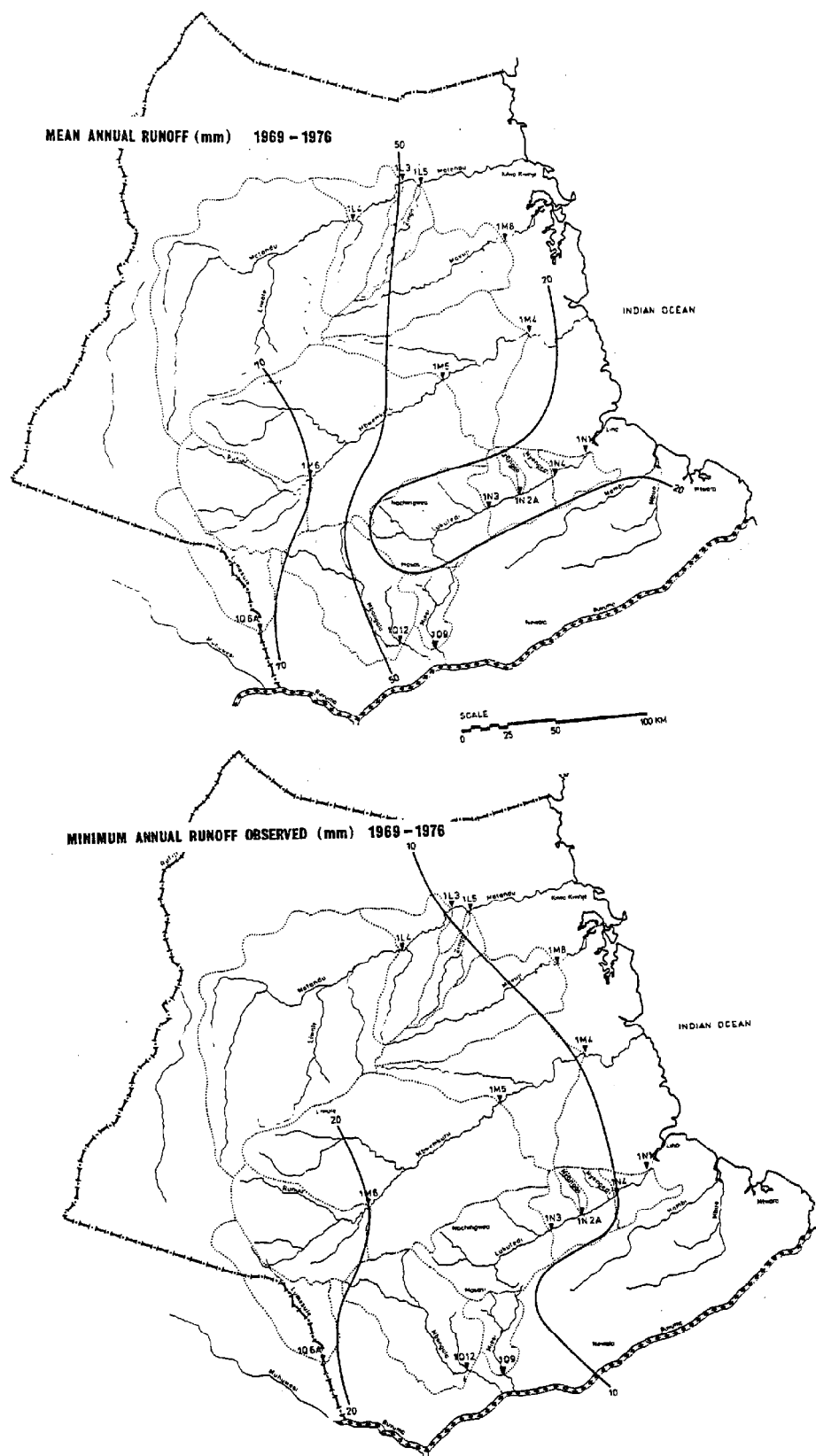


图 2-8 比流出量分布图

(出典：Mtwara-Lindi Water Master Plan Hydrology 1977)